Invasive Blood Pressure

ZOLL M Series

9650-0219-01 Rev. C

The issue date or revision level for this operation guide is shown on the front cover.

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Preface

How Do I Use This Manual?

This manual insert describes the set-up and use of the M Series Invasive Blood Pressure option. If you already know how to use the M Series, start by reading the *Safety Summary, Indications for Use* and *Introduction* sections of this insert. Familiarize yourself with all the procedures in this insert before you use the IBP option. Consult the *Troubleshooting* section if the M Series fails to operate as expected.

If you do not know how to use the M Series, see the *M Series Operator's Guide* and the relevant inserts. Thoroughly read the safety considerations and warnings sections in both the *M Series Operator's Guide* and the relevant inserts before operating your M Series product.

Place this insert in the three-ring binder along with the *M Series Operator's Guide* and all other option inserts.

Safety Summary

The following is a short summary of warnings, cautions and other safety information related to the IBP option. Additional warnings and cautions are in the text of this insert. Read this section thoroughly before operating the IBP Option.

- Read the *M Series Operator's Guide* and this manual insert before use.
- The M Series IBP option is to be operated by qualified personnel only.
- Consult a physician for the proper interpretation of pressure measurements.
- Do not use in the presence of oxygen-rich atmospheres, flammable anesthetics or other flammable agents (such as gasoline). Do not use near the site of a gasoline spill. Explosion may result.
- The use of accessories, transducers and cables other than those specified in this manual, with the exception of transducers and cables sold by ZOLL as replacement parts for internal components, may result in increased emissions or decreased immunity of the M Series.
- Route patient cabling and tubing carefully to avoid patient entanglement, strangulation or compression of tube.
- Keep patients as still as possible during measurement. Patient movement or vibrations from outside sources, particularly moving vehicles, can degrade the measurement accuracy.
- Avoid electrosurgery burns at monitoring sites by ensuring proper connection of the electrosurgery return circuit to ground. If improperly connected, some electrosurgery units allow other return paths to earth ground, even through fully isolated patient circuits in equipment operating from ac mains. If necessary, operate the monitor on battery power only to prevent a return to earth ground through the monitor.
- Do not touch the bed, patient, or any equipment connected to the patient during defibrillation. A severe shock to the operator can result.
- Do not allow exposed portions of the patient's body to come in contact with metal objects, such as a bed frame during defibrillation. Unwanted electrical pathways can result.
- If an alarm occurs while the alarms are suspended, audio alarms do not sound, only visual alarms display.

Safety Summary (cont.)

- If the accuracy of measurements is suspect, first check the IBP waveform for artifact such as catheter whip. Then check the catheter, tubing, transducer, cabling and M Series IBP option for proper functioning.
- Do not immerse the M Series device, batteries, cables, or transducers in water, solvents, or cleaning solutions.
- If the M Series device gets wet accidentally, wipe it down with a clean towel.
- Do not sterilize M Series unit or accessories except as specifically recommended in ZOLL manuals.
- Connect the ECG-out jack and modem (if available) only to other equipment with galvanically isolated circuits.
- The cable and IBP transducer(s) are defibrillator proof. Using the IBP option introduces no risk of shock due to defibrillation. Using the IBP option introduces no risk of burns due to electro-surgery.
- Do not reuse single-use transducers.
- Check the transducer packaging to make certain the transducer is sterile.
- Check the expiration date on the transducer packaging. If it has expired, replace the transducer.
- If the device is damaged by age, physical or environmental abuse, check the unit using the Maintenance Checklist to ensure its safety or remove the unit from use.
- Refer to the transducer manufacturer's specifications for information regarding volume displacement.

Indications for Use

The ZOLL M Series IBP option is indicated for measuring arterial, venous, and intracranial blood pressures using invasive transducers with 5uV/V/mmHg sensitivity for resting patients in critical care and transport. The M Series IBP option is intended for use with adult and pediatric patients only.

Contraindications for Use

The ZOLL M Series IBP option is not indicated for use on neonatal patients.

Introduction

What Can I Do with the IBP Option?

Using the IBP option you can do the following:

- Monitor two different invasive pressure channels simultaneously.
- Display two pressure traces and one ECG trace simultaneously.
- Label each Pressure channel.
- Adjust the scaling of the pressure traces.
- Display systolic, diastolic and mean blood pressure values on the screen.
- Store IBP measurements in code summary, PCMCIA memory card and trend memory.
- Print IBP waveforms, systolic, diastolic and mean pressure values.
- Configure alarms to go off when the unit detects pressure values above or below user-programmable limits.

How Do I Use the IBP Option?

To take safe and accurate pressure measurements using the M Series IBP option, you must do all of the following:

1. Select the proper transducer.
2. Connect the interface cable to the M Series and to the transducer.
3. Follow your hospital's protocol for setting up the transducer and catheter.
4. Display the IBP menu.
5. Zero the transducer.
6. Select the desired labels and ranges for each trace (if present settings are not appropriate).
7. Configure alarms (if present settings are not appropriate).
8. Read the display.

Each step corresponds to a section in this chapter. Read each section carefully before you use the M Series IBP option.

WARNING! Do not use the IBP option without proper training.

How Does the IBP Option Work?

The IBP option consists of the following:

- 5uV/V/mmHg blood pressure transducer.
- Transducer interface cable.
- Data acquisition and signal processing system inside M Series unit.

When measuring IBP with the M Series, the following occurs:

1. Pressure in the patient's vasculature is mechanically coupled to the transducer via a fluid-filled catheter/tubing system.
2. The transducer converts the pressure into an electrical signal that is measured by the M Series unit.
3. The M Series unit computes the systolic, diastolic and mean blood pressure and displays the corresponding values and the IBP trace(s).

Preparing to Take Measurements

The IBP option has two Pressure channels (P1 and P2). Either channel may be used for any type of pressure measurement (arterial, pulmonary arterial, central venous, or intracranial). Each channel has its own connector, cabling, and transducer. For each channel used you must connect the cabling and transducer to the M Series unit, and zero a transducer before you take a measurement.

Setting Up the Equipment

Turning on the monitor

To turn on the monitor:

- Turn the selector switch to **MONITOR** (**ON** for AED units).

Selecting a transducer

Use only disposable or reusable transducers with 5uV/V/mmHg sensitivity. See "Ordering Accessories" on page 16 for a list of ZOLL-approved transducers.

WARNING! The use of accessories, transducers and cables other than those specified by ZOLL may result in increased emissions or decreased immunity of the M Series.

Connecting the transducer to the unit

To connect the transducer to the M Series unit:

1. Inspect the transducer and the cable for wear, breakage or fraying. Replace cable or transducer if necessary.
2. Connect the transducer to the IBP interface cable, if applicable.
3. Connect the IBP cable to the IBP connector on the front panel of the M Series unit (see Fig. 1).

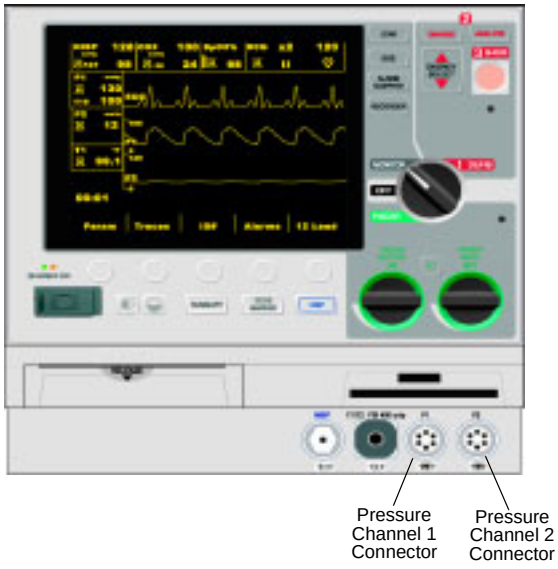

Figure 1: M Series with IBP Option

4. Verify that neither the CHECK TRANSDUCER nor the REPLACE TRANSDUCER messages display.
   If desired, repeat steps 1 - 4 to connect a second transducer. The ZERO P1 or ZERO P2 message displays. No pressure measurements will appear until the transducer has been zeroed.

Setting up the transducer and catheter

Follow manufacturer's directions for use and your hospital's protocols on how to setup, prime and flush the transducer and make connections to the pressure monitoring catheter.

Displaying the IBP Menu

Before you can zero the transducer, you must first display the IBP menu. You can display the IBP menu without leaving Monitor, Defib or Pacer mode.
AEDs must be in manual mode to display the IBP menu. See the *M Series Operator's Guide* for further details on activating the manual override mode.

To display the IBP menu:

1. Press the **Param** softkey. If the Param softkey label is not displayed, press the **Return** softkey until "Param" displays.
   The Parameter menu displays (see Fig. 2):

Figure 2: Parameter Menu

2. Press the **Select** softkey until "IBP" highlights.
3. Press the **Enter** softkey.
   M Series displays the IBP menu (see Fig. 3):

Figure 3: IBP Menu

You can now zero the transducer(s).

NOTE Unless otherwise noted, all the following procedures in this insert assume that you are already in the IBP menu.

Zeroing the Transducer

To ensure that the M Series unit measures pressure accurately, you must zero the transducer before each use. The M Series automatically displays ZERO P1 or ZERO P2 when zeroing is necessary. If you change or disconnect a transducer, you must zero the new transducer before use. If you move a transducer to a different monitor, you must zero the transducer again even if you have already done so on another unit. In addition to the procedure below, follow the transducer manufacturer's directions for use and your established clinical protocol.

To zero the transducer:

1. Place the transducer at the same height as the patient's left atrium.
2. Close the transducer stopcock to the patient.
3. Open the venting stopcock to atmospheric air.
4. Allow a few seconds for the transducer to settle.
5. Press the **Zero** softkey. If the Zero softkey is not displayed, see "Displaying the IBP Menu" on page 3.
   The Zero menu displays (see Fig. 4):

Figure 4: Zero Menu

6. Press the **Select** softkey to select the Pressure channel you want to zero.
7. Press the **Enter** softkey.
   The M Series unit zeros the selected Pressure channel(s).
8. Verify that the numeric blood pressure data displays zero and that the REZERO message does not display.
   If the REZERO message displays after you have attempted to zero the Pressure channel, repeat steps 1 - 8. If after repeated attempts, the transducer still does not zero correctly, use a different transducer.
9. Close the venting stopcock to atmospheric air.
10. Open the transducer stopcock to the patient.
    Within seconds the physiologic pressure readings display.

Taking Measurements

If the catheter, transducer and IBP cable are properly attached, the IBP traces display immediately. The IBP numerical values display once the transducer has been zeroed. Unless it is an emergency situation where quick reaction is essential, you should always check that the settings are set properly. You can access all IBP settings through the IBP menu.

When reading the blood pressure values on the display, keep in mind that the following conditions can influence IBP measurement accuracy:

- Catheter placement in the vasculature. Artifact such as catheter whip should be handled per your established clinical protocols.
- Position of the transducer stopcock, catheter and flush port.
- Saline line flushes which will temporarily interrupt accurate pressure measurement.
- Position of the transducer relative to the patient's phlebostatic axis or catheter tip.
- Patient movement.
- Catheter clogging.
- Air bubbles in catheter or transducer dome.

CAUTION! Flush catheter regularly while taking IBP measurements. Always view the IBP trace to ensure pressure measurements are based on a physiological waveform.

Reading the Display

Pressure channels 1 and 2 each have their own data display area and waveform display area. Either channel may be used for any type of pressure measurement (arterial, pulmonary arterial, central venous, or intracranial).

The *IBP Data display areas* display the following information:

- Systolic blood pressure value.
- Diastolic blood pressure value.
- Mean blood pressure value.
- Alarm status.
- Unit of measurement.

The *Trace display area* (lower right quadrant of screen) displays three traces:

- Trace 1 - reserved for ECG.
- Trace 2 - Pressure channel 1 (or $EtCO_2$, SpO_2, 3 Lead ECG if selected).
- Trace 3 - Pressure channel 2 (or $EtCO_2$, SpO_2, 3 Lead ECG if selected).

See "Changing the displayed traces" on page 8 for further details.

To access most IBP features you must press a *softkey* with the proper *softkey label* (see Fig. 5*)*.

NOTE Depending on the options included in your M Series, your front panel and display may slightly differ from the illustrations in this insert.

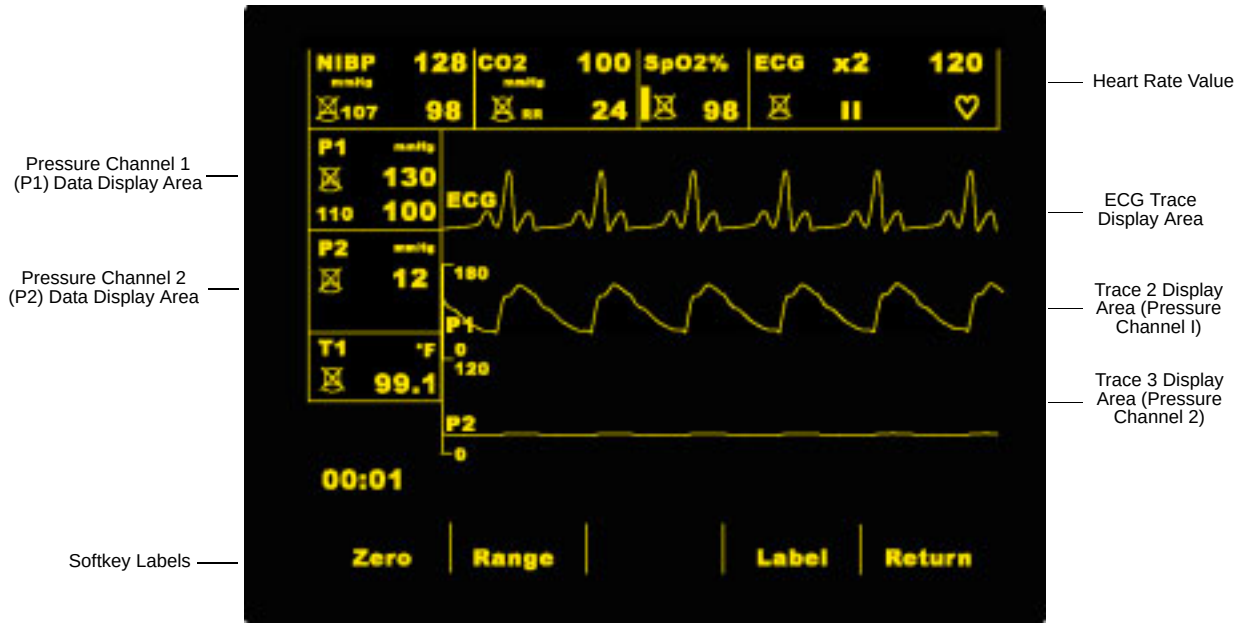

Figure 5: M Series Display with IBP Option

The source of the displayed Heart Rate values depends upon the signals being monitored by the M Series unit:

- If the ECG signal is present, the ECG heart rate displays.
- If the ECG signal is *not* present, but pulsatile IBP signal is present, the IBP pulse rate displays (regardless of whether the SpO_2 signal is present). P1 takes precedence over P2.
- If neither the ECG nor pulsatile IBP signals are present, the SpO_2 pulse rate displays.

The IBP display area consists of:

- Symbols that represent the status of pressure measurements.
- Numbers that represent the measurement values (see Fig. 6 and Fig. 7):

Figure 6: IBP Data Display Area - ART, PA, P1

Figure 7: IBP Data Display Area - CVP, ICP, P2

Either channel (P1, P2) may be used for any type of pressure measurement (arterial, pulmonary arterial, central venous, or intracranial). The M Series default unit of measure is millimeters of mercury (mmHg), but you can configure the M Series to display kilopascals (kPa). See the *M Series Configuration Guide* for instructions on how to configure alternate units of measure.

Changing the Display

You can change how the M Series unit displays IBP data and traces. Any changes to these settings remain in effect until either the settings are changed or 10 seconds after the M Series is turned off.

Changing the displayed traces

When in Monitor or Defib mode, the M Series unit displays three traces. While Trace 1 always displays ECG, you can select the type of waveform displayed for Traces 2 and 3. When the M Series unit is in Pacer mode, display messages take the place of Trace 3.

To select the displayed traces:

1. Press the **Traces** softkey. If Trace softkey label is not displayed, press the **Return** softkey until "Traces" displays.
   The Traces menu displays (see Fig. 8):

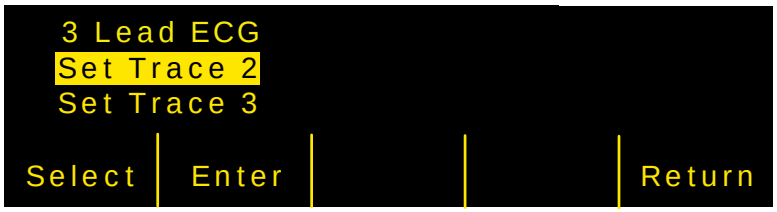

Figure 8: Traces Menu

2. Press the **Select** softkey to select the trace you want to change.
3. Press the **Enter** softkey.
   The Trace Options menu displays (see Fig. 9):

Figure 9: Trace Options Menu

4. Press the **Select** softkey to select the type of waveform you want to display. Note that you cannot select a waveform that is already displayed on a different trace.
5. Press the **Enter** softkey.
   M Series unit displays the selected waveform. If desired, repeat steps 1 - 5 to change the other trace.

Changing the trace labels

Each Pressure channel has a unique label in the IBP display area (see the "Reading the Display" on page 6 for further details). The generic labels are “P1” for Pressure channel 1 and “P2” for Pressure channel 2. These labels appear in the IBP display areas, summary reports, and strip charts. For ease of use, you can set these labels to indicate the type of pressure measurement in use.

You can change either of these labels to one of the following:

- ART (arterial blood pressure)
- PA (pulmonary arterial pressure)
- CVP (central venous pressure)
- ICP (intracranial pressure)

To change the trace label:

1. Press the **Label** softkey. If the Label softkey is not displayed, see "Displaying the IBP Menu" on page 3.
   The Label menu displays (see Fig. 10):

Figure 10: Label Menu

2. Press the **Select** softkey to select the label you want to change.
3. Press the **Enter** softkey.
   The Label Options menu displays (see Fig. 11):

Figure 11: Label Options Menu

4. Press the **Select** softkey to select the label you want to display.
5. Press the **Enter** softkey.
   M Series unit displays the selected label. If desired, repeat steps 1 - 5 to change the other label.

Changing the displayed range

Each IBP trace has a range that consists of upper and lower limits. By changing the displayed range, you can change the size of the IBP waveform.

To change the displayed range:

1. Press the **Range** softkey. If the Range softkey is not displayed, see "Displaying the IBP Menu" on page 3.
   The Range menu displays (see Fig. 12):

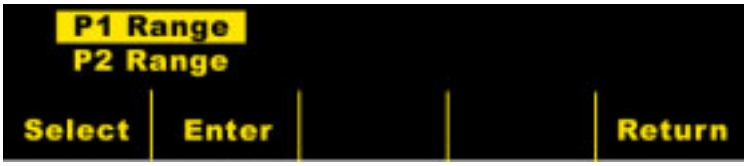

Figure 12: Range Menu

2. Press the **Select** softkey to select the pressure channel whose range you want to change.
3. Press the **Enter** softkey.
   The Range Options menu displays (see Fig. 13):

Figure 13: Range Options Menu

4. Press the **Select** softkey to select the range you want to display.
5. Press the **Enter** softkey.
   M Series unit displays the trace with the selected range. If desired, repeat steps 1 - 5 to change the other pressure channel range.

Setting Alarms

Before taking measurements, check that all IBP alarms settings are appropriate for the situation. You can set the alarms for Pressure channel 1, Pressure channel 2 and NIBP separately. See *M Series Operator's Guide* for instructions on setting alarms.

CAUTION! Before the M Series with IBP option is initially put into service, the IBP alarm limit defaults should be configured per institutional guidelines. See the *M Series Configuration Guide* for further details.

The M Series IBP option includes blood pressure alarms for the following measurements:

Table 1: Alarm Limit Settings and Defaults - Arterial Pressure (ART)

Alarm Limit:	Default Setting:	Range (increments of 5):
High Systolic	160 mmHg; 21.3 kPa	-45 to 300 mmHg; -6.0 to 39.9 kPa
Low Systolic	90 mmHg; 12.0 kPa	-50 to 295 mmHg; -6.7 to 39.2 kPa
High Diastolic	110 mmHg; 14.6 kPa	-45 to 300 mmHg; -6.0 to 39.9 kPa
Low Diastolic	50 mmHg; 6.6 kPa	-50 to 295 mmHg;-6.7 to 39.2 kPa
High Mean	130 mmHg; 17.3 kPa	-45 to 300 mmHg; -6.0 to 39.9 kPa
Low Mean	60 mmHg; 8.0 kPa	-50 to 295 mmHg; -6.7 to 39.2 kPa

Table 2: Alarm Limit Settings and Defaults - Pulmonary Arterial Pressure (PA)

Alarm Limit:	Default Setting:	Range (increments of 5):
High Systolic	300 mmHg; 39.9 kPa	-45 to 300 mmHg; -6.0 to 39.9 kPa
Low Systolic	-50 mmHg; -6.7 kPa	-50 to 295 mmHg; -6.7 to 39.2 kPa
High Diastolic	300 mmHg; 39.9 kPa	-45 to 300 mmHg; -6.0 to 39.9 kPa
Low Diastolic	-50 mmHg; -6.7 kPa	-50 to 295 mmHg;-6.7 to 39.2 kPa
High Mean	300 mmHg; 39.9 kPa	-45 to 300 mmHg; -6.0 to 39.9 kPa
Low Mean	-50 mmHg; -6.7 kPa	-50 to 295 mmHg; -6.7 to 39.2 kPa

Table 3: Alarm Limit Settings and Defaults - Central Venous Pressure (CVP)

Alarm Limit:	Default Setting:	Range (increments of 5):
High	300 mmHg; 39.9 kPa	-45 to 300 mmHg; -6.0 to 39.9 kPa
Low	-50 mmHg; -6.7 kPa	-50 to 295 mmHg; -6.7 to 39.2 kPa

Table 4: Alarm Limit Settings and Defaults - Intracranial Pressure (ICP)

Alarm Limit:	Default Setting:	Range (increments of 5):
High	300 mmHg; 39.9 kPa	-45 to 300 mmHg; -6.0 to 39.9 kPa

Alarm Limit:	Default Setting:	Range (increments of 5):
Low	-50 mmHg; -6.7 kPa	-50 to 295 mmHg; -6.7 to 39.2 kPa

When the M Series is turned on, all alarm functions are disabled and the alarm limits are set to their default values. Any changes to these settings remain in effect until either the settings are changed or 10 seconds after the M Series is turned off.

Setting alarm limits

You can change all the alarm limits using the standard M Series procedures. See *M Series Operator's Guide* for instructions on setting alarm limits.

You can set the alarm limits using the Auto function, or you can choose your own limits (see above table). The Auto function sets the high limit to 30 mmHg (4.0 kPa) above and the low limit to 20 mmHg (2.7 kPa) below the measured pressure when alarm limits are set.

Enabling, disabling and suspending alarms

You can enable, disable and suspend all IBP alarms using the standard M Series procedures. See *M Series Operator's Guide* for instructions on enabling, disabling, and suspending alarms.

Changing the status of one Pressure channel alarm automatically sets the other alarms for that channel to the same status. For example, if you enable the Pressure channel 1 systolic alarm, all other Pressure channel 1 alarms are automatically enabled. Or if you disable the Pressure channel 2 diastolic alarm, all other Pressure channel 2 alarms are automatically disabled.

Setting alarms for one Pressure channel has no affect on the alarms for the other Pressure channel. Enabling, disabling or suspending IBP alarms does not affect the status of other M Series alarms.

Clearing IBP alarms

An audible alarm and flashing softkey activate when an IBP signal transitions from pulsatile to non pulsatile. This alarm only functions on IBP channels labeled P1, ART, and PA. The alarm is triggered when the difference between the systolic and diastolic pressure drops to less than three (3) mmHg for more than three (3) seconds.

The alarm must be cleared manually.

When the alarm activates, the **Clear IBP Alarm** display appears as shown in Fig. 14, flashing in inverse video.:

Figure 14: Clear IBP Alarm display

To clear the alarm:

- Press the **Clear IBP Alarm** softkey, the display returns to the standard display.

Printing IBP Data

See the *M Series Operator's Guide* Recorder Operation section for instructions on how to print data. If you are currently displaying IBP traces, press the RECORDER button to print a strip chart that includes the following values for the currently displayed trace:

- One or two IBP traces (whichever is currently displayed).
- Systolic blood pressure.
- Diastolic blood pressure.
- Mean pressure.
- Time of measurement.

Maintaining the IBP Option

See the *M Series Service Manual* for instructions on maintaining the IBP option.

Performing the Daily Checkout Procedure

The following is a checkout procedure that should be performed daily to ensure that the IBP option is functioning properly. In addition, this daily checkout procedure ensures that medical personnel maintain familiarity with the proper use of the IBP option.

Use only 5uV/V/mmHg IBP simulators. See "Ordering Accessories" on page 16 for further details. For more specific instructions on how to accomplish each step listed below, refer to the related section in this manual.

To perform the daily checkout procedure:

1. Connect the IBP simulator cable to the M Series unit and the IBP simulator.
2. Set the simulator to zero.
3. Zero the transducer.
4. Set the simulator to simulate 50 mmHg.
5. Verify that the M Series displays systolic, diastolic and mean pressures of 50 mmHg +/- 6 mmHg.
6. Set the simulator to simulate 250 mmHg.
7. Verify that the M Series displays systolic, diastolic and mean pressures of 250 mmHg +/- 6 mmHg.

Specifications

For a list of alarm defaults and ranges, see "Setting Alarms" on page 11.

Table 5: General Specifications

Principle of Operation	Resistive Bridge transducer; 5uV/V/mmHg sensitivity (transducers with 40uV/V/mmHg sensitivity are **not** compatible)
Regulatory Standards	EN60601-2-34:1995

Table 6: IBP Measurement Specifications

Pressure Range	-50 to 300 mmHg after offset adjustment
Zero Offset Adjust Range	+/- 200 mmHg
Accuracy	Greater of +/- 2% measurement or +/- 2 mmHg, plus transducer error
Baseline Stability	+/- 0.1 mmHg/° C excluding transducer drift
Bandwidth	DC to 20 Hz
Noise	< 1 mmHg peak-to-peak
Transducer Impedances	Input: minimum 250 Ω Output: maximum 3000 Ω
Transducer Excitation	2.5 V DC

Table 7: Battery Operating Time Specifications (using ZOLL XL Battery Pack)

For a new, fully charged battery pack at 20°C with IBP, $EtCO_2$, SpO_2, NIBP and Temperature options	60 defibrillator discharges at maximum energy (200J Biphasic), or 1.75 hours minimum of continuous ECG, IBP (2 channels), $EtCO_2$, SpO_2, and Temperature monitoring, or 2.00 hours of continuous ECG monitoring/pacing at 60 mA, 70 beats/min.

Table 8: Environmental Specifications

Operating Temperature	0 °C to 50 °C
Storage and Shipping Temperature	-20 °C to 60 °C
Electromagnetic Immunity	AAMI DF-2: 1996, EN 61000-4-3: 1996, 15 V/m
Humidity	5% to 95% relative humidity, non-condensing
Operating Pressure	594 mBar to 1060 mBar

Software License

Read this License agreement carefully before operating any of the M Series products.

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Possession or purchase of this device does not convey any express or implied license to use the device with replacement parts which would, alone, or in combination with this device, fall within the scope of one or more of the patents relating to this device.

Ordering Accessories

To order accessories for the M Series IBP option call ZOLL Customer Service at 1-800-348-9011. Customers outside the United States should call the nearest authorized ZOLL Medical Corporation sales representative. The following tables list optional accessories that can be used with the M Series IBP option:

Table 9: ZOLL-approved IBP Transducers

Item:	ZOLL Part Number:	Manufacturer Contact Information:
Abbott Critical Care Systems Transpac IV	N/A	Abbott Critical Care Systems North Chicago, IL 60064 (800) 222-6883
Baxter Edwards TruWave	N/A	Baxter/Edwards Lifesciences LLC One Edwards Way Irvine, CA 92614 (949) 250-2500
Utah Medical Deltran IV	8000-0666	Utah Medical Products Inc. 7043 South 300 West Midvale, UT 84047 (801) 566-1200
Becton Dickinson Gabarith PMSET 1DT-XX	N/A	Becton Dickinson 1 Becton Drive Franklin Lakes, NJ 07417 (201) 847-6800
B. Braun Exadyn-Combitrans	N/A	B. Braun Carl-Braun-Strasse 1 D-34212 Melsungen Germany +49/5661/71-0

Table 10: ZOLL-approved IBP Simulators

Item:	ZOLL Part Number:	Manufacturer Contact Information:
Fogg BP 28 simulator w cable	8000-0667	Fogg System Company, Inc. 15592 East Batavia Drive Aurora, CO 80011 (303) 344-1883

Troubleshooting

The following table lists the IBP messages, the problem each message indicates, and the actions you should take to fix the problem. Read this section carefully before monitoring patients. For further assistance, call ZOLL Technical Service at 1-800-348-9011. Customers outside the United States should call the nearest authorized ZOLL Medical Corporation sales representative.

CAUTION! Determine that altered waveform and pressure are not the result of physiologic changes requiring immediate action prior to systematic troubleshooting.

Message/Symptom:	Problem:	User Action:
CHECK P1 TRANSDUCER CHECK P2 TRANSDUCER	The transducer connection is broken. A short or open circuit is detected in the transducer.	Check transducer and cabling. Replace the transducer or cabling.
ICU ERROR XXX	No communication from the IBP processor. BP processor failed self-test.	Turn unit off, wait 10 seconds and retry. If problem persists, return unit to ZOLL Technical Service.
REPLACE P1 TRANSDUCER REPLACE P2 TRANSDUCER	Transducer signal is incompatible with M Series unit.	Use transducer that is compatible with M Series unit.
REZERO P1 REZERO P2	M Series unit was unable to establish a zero reference value.	Rezero the transducer.
SYSTEM FAULT	Communication problem with the IBP processor.	Turn unit off, wait 10 seconds and retry. If problem persists, return unit to ZOLL Technical Service.
ZERO P1 ZERO P2	No zero reference has been established.	Zero the transducer.
No BP waveform	Large leak in the tubing system. Transducer interface cable is loose. Display scale set improperly. Mechanical coupling between catheter and transducer is compromised. Defective transducer.	Check for leaks in the tubing/catheter system*. Assure connections are made. Replace cable if necessary. Rescale displayed trace. Check that stopcocks are in the proper position for monitoring. Check for kinks in tubing. Check for blood clots in tubing. Replace transducer.

WARNING! * Leaks in the tubing/catheter system may effectively cause the patient to hemorrhage.

Message/Symptom:	Problem:	User Action:
BP numerical readout displays as "-----"	Transducer has not been zeroed.	Zero the transducer.
Arterial BP waveform distorted.	Catheter whip. Overdamped system. Underdamped system.	Follow institutional procedures to eliminate catheter whip. Check for the presence of blood clots. Check for blood remaining in the catheter following blood sampling. Check for air bubbles in the entire fluid circuit. Eliminate these as necessary. Remove all air bubbles, including pinpoint air bubbles from the fluid circuit.
Pressure readings too high or too low (after verification of non-physiologic changes in patient).	Air bubbles in the fluid*. Clotted blood at catheter tip or within catheter lumen. Kinks or knots in the catheter or tubing. Catheter whip. Leak or loose connection in the tubing system. Patient position changes.	Remove all air bubbles, including pinpoint air bubbles, per institutional procedures. Clear clotted blood from the line per institutional procedures. Check for adequate line irrigation. Remove kinks or knots in catheter and tubing. Follow institutional procedures to eliminate catheter whip. Tracking changes in mean pressures may be beneficial, as mean pressures are less affected by bobbing catheter. Check for leaks in the tubing/catheter system**. Check position of transducer relative to phlebostatic axis. Reposition transducer and rezero as necessary.

WARNING! * Air in the monitoring line risks accidental air embolization associated with significant patient morbidity.

WARNING! ** Leaks in the tubing/catheter system may effectively cause the patient to hemorrhage.

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